

nized a perfectly similar canal, terminated by a pavilion and placed in the same situation. As in *Pedicellina*, it appears very early in the bud.

In the group Endoprocta, including the highest forms of the Bryozoa, we may therefore regard as constant the presence of a segmental organ—that is to say, an organ which is very generally diffused among the Vermes.

Considering the endeavours that have been made of late years to approximate the Bryozoa to the Annulata, I have thought it an advantage to bring this new argument into the debate, as it seems to me to possess a real value.—*Comptes Rendus*, February 24, 1879, p. 392.

The Origin of the specialized Teeth of the Carnivora.

By E. D. COPE.

The specially developed teeth of the Carnivora are the canines and sectorials. The former are large in many orders of Mammalia; and their origin is probably to be sought among the Theromorphous Reptilia*, such as *Clepsydraps* and *Deuterosaurus*, if not in still lower types. The successive modifications of form which have resulted in the existing specialized single sectorial tooth of the Felidæ have been already pointed out †. They were shown to consist in the gradual obliteration of the internal and posterior tubercles and the enlargement of the external anterior tubercle in connexion with an additional anterior tubercle. The modification in the character of the dentition, taken as a whole, was shown to consist in the reduction in the number of teeth, including the sectorials, until in *Felis* &c. we have almost the entire function of the molar series confined to a single large sectorial in each jaw.

Observation on the movements of the jaws of Carnivora shows that they produce a shearing motion of the inferior on the superior teeth. This is quite distinct from the subhorizontal movement of Ruminants, or the vertical motion of hogs and monkeys. Examination of the crowns of the sectorials shows that the inner side of the superior and the external side of the inferior are worn in the process of mastication. The attempt to cut the tough and stringy substances found in animal bodies is best accomplished by the shearing of the outer edge of the lower molar on the inner edge of the external tubercles of the superior molar in an animal with simple tubercular teeth. The width of the mandible is too great to allow the inferior teeth to shear on the inner edge of the inner tubercles of the superior series. The cusps of both superior and inferior teeth engaged in this process have developed in elevation at the expense of those not engaged in it, viz. the internal cusps of the same teeth. The atrophy of the latter cannot have been due to friction, since the internal cusps of the inferior series, which have

* 'American Naturalist,' 1878, p. 829.

† Cope, 'Proceedings Academy Philad.' 1865, p. 22.

not been subjected to it, are reduced like those of the superior sectorial, which have. Indeed it is possible that some of the Creodonta, the carnivores of the lower Eocene, may have been derived from ancestors without or with rudimental inner cusps. In any case the effect of use in lengthening the cusps appears to have operated in the Carnivora, as it has done to a greater degree in the Ungulata; and the lateral vertical wear would appear to have resulted in the blade-form, as transverse wear in the Ungulates has resulted in the plane grinding surface.

The specialization of one tooth to the exclusion of others as a sectorial, appears to be due to the following causes. It is to be observed, in the first place, that when a carnivore devours a carcass, it cuts off masses with its sectorials, using them as shears. In so doing it brings the part to be divided to the angle or canthus of the soft walls of the mouth, which is at the front of the masseter muscle. At this point the greatest amount of force is gained, since the weight is thus brought immediately to the power, which would not be the case were the sectorial situated much in front of the masseter. On the other hand, the sectorial could not be situated further back, since it would then be inaccessible to a carcass or mass too large to be taken into the mouth.

The position of the sectorial tooth being thus shown to be dependent on that of the masseter muscle, it remains to ascertain a probable cause for the relation of the latter to the dental series in modern Carnivora. Why, for instance, were not the last molars modified into sectorial teeth in these animals, as in the extinct *Hyænodon* and various Creodonta? The answer obviously is to be found in the development of the prehensile character of the canine teeth. It is probable that the gape of the mouth in the *Hyænodons* was very wide, since the masseter was situated relatively far posteriorly. In such an animal the anterior parts of the jaws with the canines had little prehensile power, as their form and anterior direction also indicates. They doubtless snapped rather than lacerated their enemies. The same habit is seen in the existing dogs, whose long jaws do not permit the lacerating power of the canines of the Felidæ, though more effective in this respect than those of the *Hyænodons*. The usefulness of a lever of the third kind depends on the approximation of the power to the weight; that is, in the present case, the more anterior the position of the masseter muscle, the more effective the canine teeth. Hence it appears that the relation of this muscle to the inferior dental series depended originally on the use of the canines as prehensile and lacerating organs, and that its insertion has advanced from behind forwards in the history of carnivorous types. Thus it is that the only accessible molars, the fourth above and the fifth below, have become specialized as sectorials, while the fifth, sixth, and seventh have, first, remained tubercular as in the dogs, or, secondly, have been lost, as in hyenas and cats.—*American Naturalist*, March 1879.